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Van Mullem et al.

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(54) **ROCK CRUSHER SEAL**

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(52) **U.S. Cl.** **241/209**; 241/216
(58) **Field of Search** 241/207–216

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,633,316	A	*	1/1972	Belser	16/225
3,924,815	A		12/1975	Haggren	
4,179,076	A		12/1979	Barrot et al.	
4,384,684	A		5/1983	Karra	
4,410,143	A		10/1983	Polinski	
4,467,971	A		8/1984	Schuman	
4,478,373	A		10/1984	Gieschen	
4,519,551	A		5/1985	Ceurvorst	
4,659,026	A		4/1987	Krause et al.	
4,750,679	A		6/1988	Karra et al.	
4,919,348	A	*	4/1990	Johnson et al.	241/215
5,022,593	A		6/1991	Stelk	
5,031,843	A		7/1991	Motz	
5,080,294	A		1/1992	Dean	
5,372,318	A		12/1994	Jacobson	
5,769,340	A		6/1998	Jean	
5,775,607	A	*	7/1998	Bayliss et al.	241/207
5,803,382	A		9/1998	Ganser, IV et al.	
5,810,269	A		9/1998	Shannon	
5,915,638	A		6/1999	Jean	
5,934,583	A		8/1999	Jean	
5,938,133	A		8/1999	Bayliss et al.	
5,944,265	A		8/1999	Ganser, IV et al.	
5,964,422	A		10/1999	Ruokonen et al.	
5,996,916	A		12/1999	Musil	
6,007,009	A		12/1999	Sheridan et al.	

* cited by examiner

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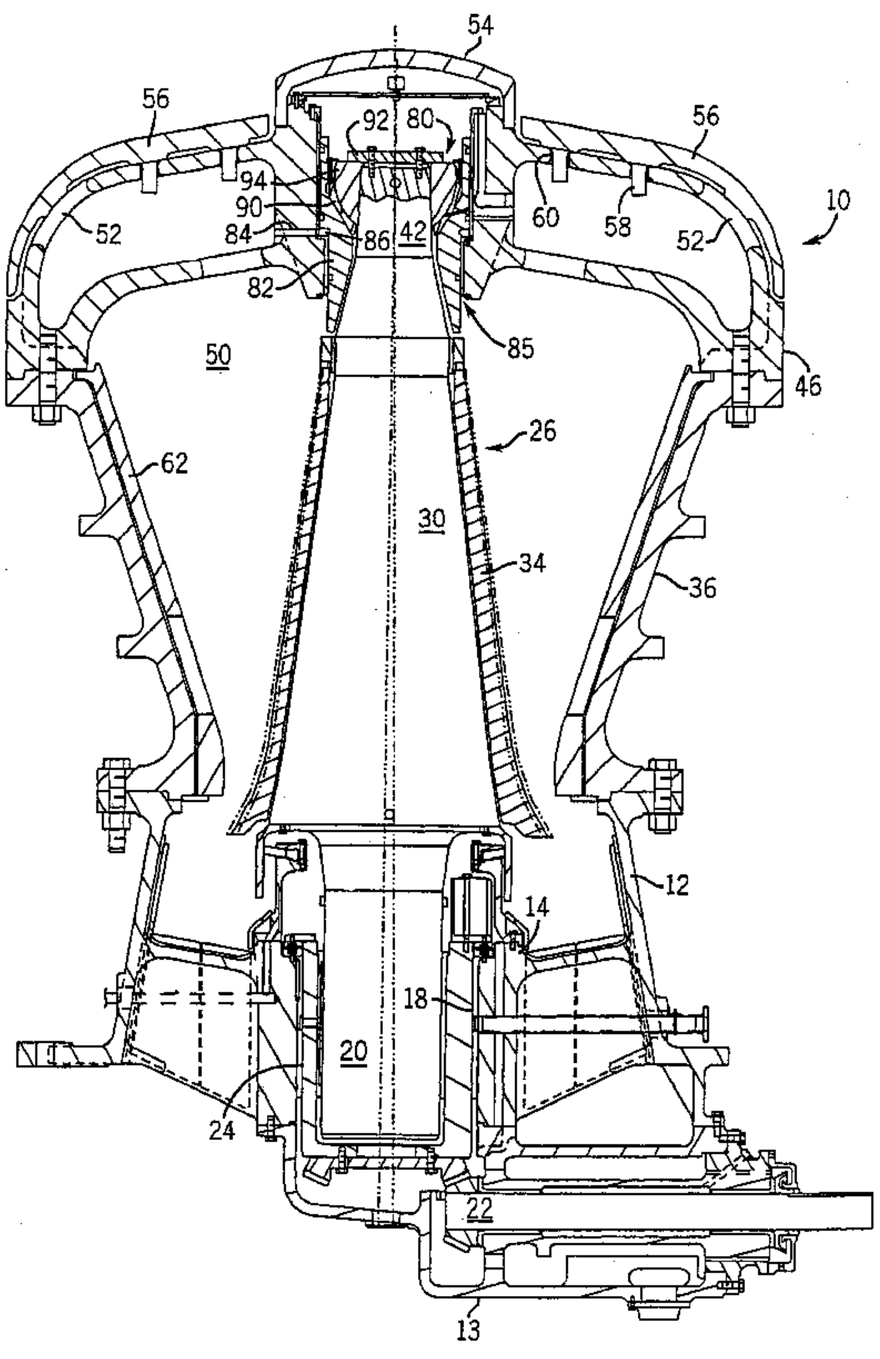
(57) **ABSTRACT**

A socket seal for a gyratory crusher is comprised of a ring with a pair of lips extending therefrom. The ring can have an outwardly expanding dovetail which is inserted into a slot in the piston or hemispherical bearing socket. The seal prevents downward flow of oil from the lubricated space between the hemispherical bearing ball and socket.

30 Claims, 2 Drawing Sheets



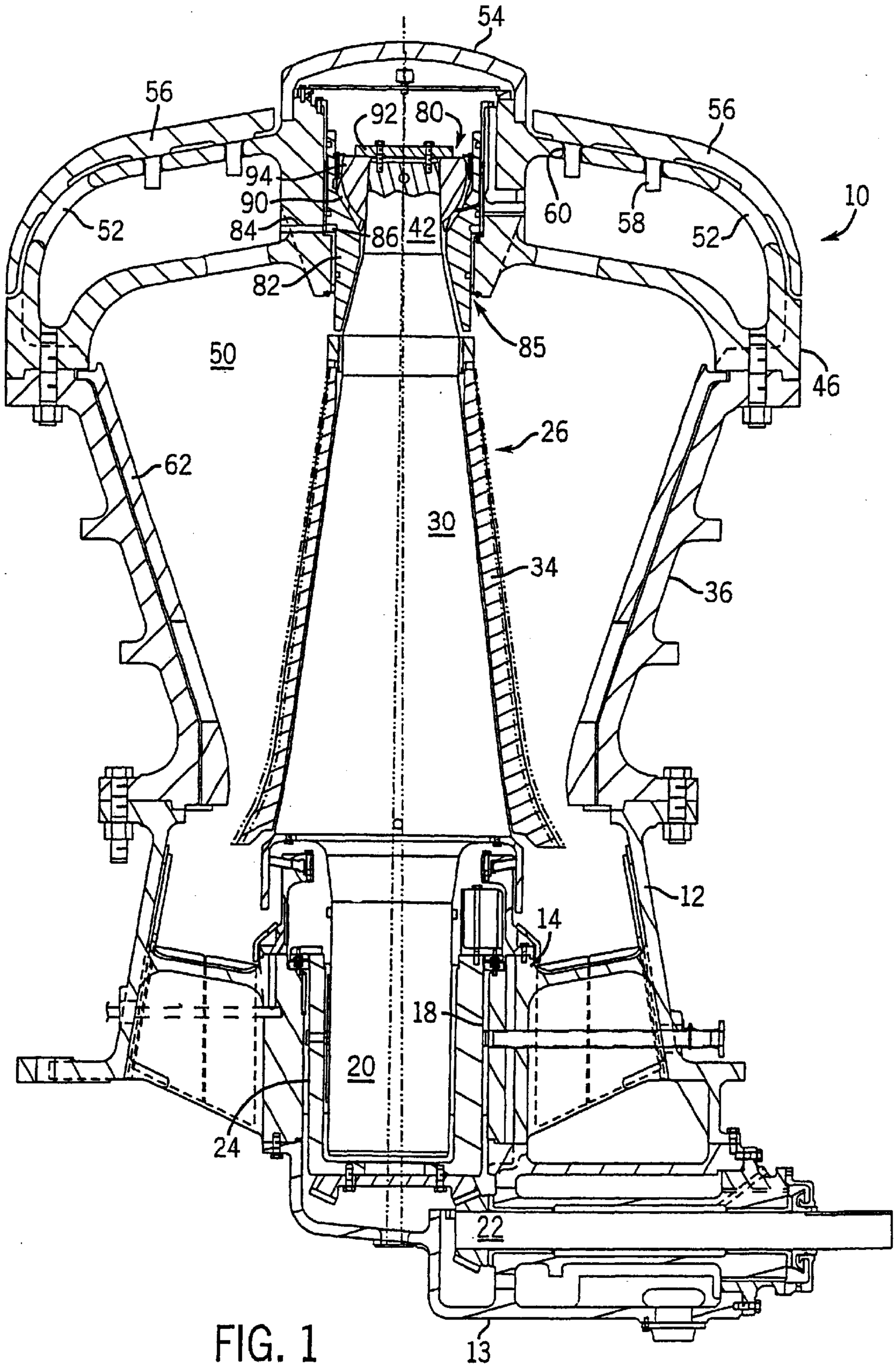

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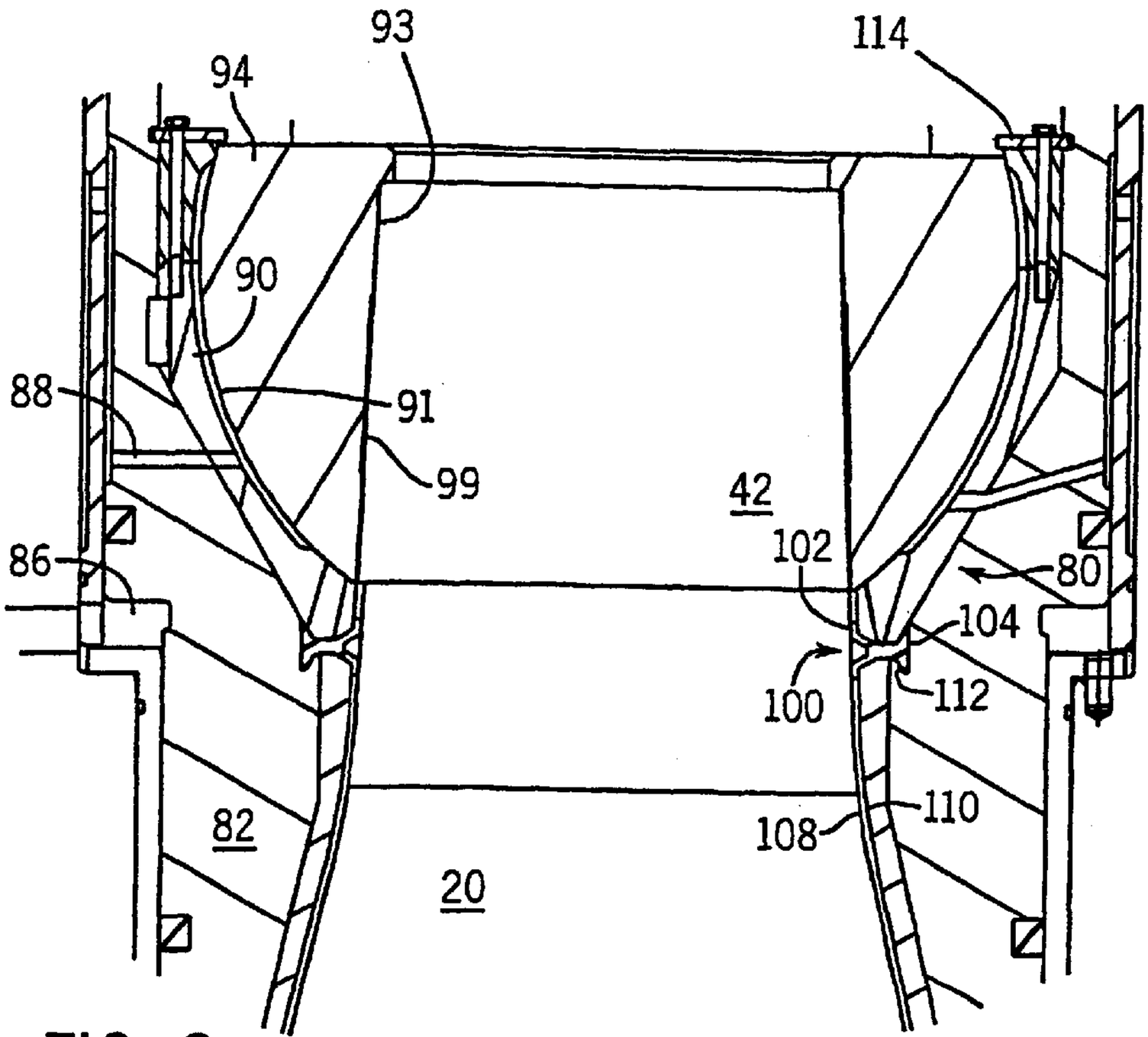
FIG. 1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112
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FIG. 2


104
102
106
105
107

FIG. 3

ROCK CRUSHER SEAL

FIELD OF THE INVENTION

The present invention relates to rock crushing systems, such as conical rock crushers or gyratory crushers. More specifically, the present invention relates to a bearing lubrication system socket seal for rock crushers.

BACKGROUND OF THE INVENTION

Gyratory rock crushers generally have a downwardly expanding central conical member which rotates or gyrates within an outer upwardly expanding frustroconically shaped member typically called a shell. The shell can be comprised of two or more pieces, e.g., a top shell and a bottom shell. The central conical member generally has a wearing cover or a liner called a mantle.

A spider assembly rests on the top shell, forming the top of the support structure for the machine. The spider assembly is designed to support the shaft while allowing gyratory movement during operation of the machine.

A shaft extends vertically through the rock crusher. This shaft is supported by a bearing in the spider assembly. The central portion of the shaft tapers inwardly in an upward direction to form the central conical crushing member. The central portion of the shaft supports the mantle, which moves with the shaft to effect the gyratory crushing operation.

The vertical position of the shaft with respect to the spider assembly is controlled by a piston arrangement in the spider assembly. The piston arrangement is a complex mechanical apparatus including a piston, a bearing, and an attachment system. The piston is slidably disposed within the spider assembly. The bearing is supported by the piston and supports the shaft while allowing gyratory motion. The bearing has a hemispherical ball disposed in a socket; the hemispherical ball is lubricated by a lubricant such as oil. The attachment system is required to clamp the ball to the shaft.

A lubricant is pumped into a space between ball and socket of the bearing. The lubricant exits through a drain at the top of the spider. A seal, known as a socket seal, below the bearing prevents the lubricant from leaking downward into the crushing chamber. The seal is disposed between the shaft and the piston.

The conventional designs for the seal have several drawbacks. First, the conventional designs do not offer any redundancy in the event a part of the seal fails. Second, conventional seals require additional hardware. Third, conventional seals tend to lose integrity due to the gyratory motion of the shaft. Thus, the performance of conventional seals can be increased.

Therefore, it would be advantageous to have a socket seal that has built-in redundancy. Further, there is a need for a socket seal that may be installed by hand. Further still, there is a need for a socket seal that does not lose contact with either the shaft or piston while the crusher is operating.

SUMMARY OF THE INVENTION

An exemplary embodiment relates to a gyratory crusher. The gyratory crusher has a shell, a spider supported by the shell, a piston disposed within the spider, a bearing supported by the piston, and a shaft supported by the bearing. The gyratory crusher has an annular seal extending between the piston and the shaft. The seal has a number of lips.

Another embodiment relates to a socket seal for a gyratory crusher. The gyratory crusher has a shaft supported by a bearing disposed within a piston. The socket seal includes a ring having a first edge and a second edge. The seal has at least two lips extending from the first edge of the ring. The seal is disposed between the shaft and the piston. The seal is coupled to both the shaft and the piston during operation of the gyratory crusher.

A further embodiment relates to a method of installing an annular seal in a gyratory crusher. The gyratory crusher includes a shell, a spider supported by the shell, and a piston disposed within the spider. The crusher also includes a bearing having a ball and a socket supported by the piston, a shaft supported by the bearing, and a seal space. The seal space is defined by the socket, piston, and shaft. The method includes the steps of providing the annular seal and removing the bearing. Access is gained to the seal space by removing the bearing. The method then includes installing the seal in the seal space.

A still further embodiment relates to a gyratory crusher including a shell, a spider, a piston, a bearing, a shaft, and an annular seal. The spider is supported by the shell and the piston is disposed within the spider. The bearing is supported by the piston and has a ball and socket defining a lubricated interface. The shaft is supported by the bearing. The annular seal has a plurality of lips. The seal is disposed below the lubricated interface. The seal prevents downward flow of lubricant.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements, and:

FIG. **1** is a vertical cross-sectional view of a gyratory crusher;

FIG. **2** is a more detailed cross-sectional view of a bearing and socket seal of a gyratory crusher; and

FIG. **3** is a cross-sectional view of the socket seal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, a gyratory crusher **10** can be utilized to crush rock, ore, minerals, waste, or other material. Gyratory crusher **10** is assembled on a cast steel base or bottom shell **12** having a central hub **14**. Central hub **14** is provided with a vertical bore **18** adapted to receive a cylindrical support shaft **20** and eccentric **24**. Shaft **20** varies in cross section, but extends through the machine into the spider **46**. Drive housing **13** extends outwardly from hub **14** to enclose a drive mechanism **22**. Drive mechanism **22** causes rotation of the eccentric **24** which directs the gyratory motion of the shaft **20**.

A head assembly **26**, which is part of the shaft **20**, includes a head member **30** which is covered by a mantle **34**. Mantle **34** provides one of the crushing surfaces of crusher **10**.

A top shell **36** projects upwardly from bottom shell **12** and is covered by a spider assembly including a spider **46**. Alternatively, top shell **36** and bottom shell **12** can be a single piece component. Spider **46** receives an end **42** of shaft **20**.

Top shell **36** is protected from wear by several rows of concaves **62**. Concaves **62** provide the crushing surface opposing mantle **34**. Spider **46** can be attached or rest upon top shell **36**. Vertical positioning of shaft **20** with respect to top shell **36** adjusts the relative position of concaves **62** with respect to the mantle **34** of the head member **30**, thereby adjusting the size of the crushed material exiting crusher **10**.

Material to be crushed is supplied through spider **46** which includes openings for entry of the material into crushing cavity **50**. A liquid flush apparatus (not shown) may be provided for spraying a liquid such as water toward the crusher cavity **50**.

Spider **46** is comprised of spider arms **52** radially extending outward from the center to a spider rim (not shown). A spider cap **54** sits on the top center of the spider **46**. Each of the spider arms **52** is protected from falling material by a spider arm guard **56**. The rim of spider **46** is protected by a rim liner, also known as a hopper liner.

Shaft **20** is supported by a bearing **80** within spider **46**. The bearing **80** has a ball **94** disposed within a socket **90**. The bearing **80** is disposed within a piston **82** that travels vertically within spider **46** to adjust the vertical positioning of shaft **20**. Piston **82** is slidably disposed within an aperture **85** of spider **46**. Piston **82** is moved by a hydraulic system. The hydraulic system includes a hydraulic fluid inlet **84**, and a hydraulic fluid ring **86** that is filled to move piston **82** vertically. A bearing retainer plate **92** is used to secure shaft **20** to ball **94**.

Referring to FIG. **2**, socket retaining plates or ring **114** is bolted onto socket **90**. Ball **94** has a hemispherical structure designed to receive top end **42** of shaft **20**. Ball **94** includes aperture **93** for receiving end **42**. Aperture **93** is tapered in accordance with the taper associated with end **42**. Aperture **93** includes a groove **99**. Groove **99** serves to aid in the removal of ball **94** from shaft **20** when the groove **99** is pressurized. In a preferred embodiment, the ball **94** has a radius of about 13.4 inches and is lubricated by oil within grooves **91** of socket **90**.

Shaft **20** is disposed in and supported by bearing **80**. The bearing is lubricated by oil that is input through the lubricating oil inlet **88**. The oil travels throughout the bearing and exits through a drain hole at the top of the spider **46**. A seal is required to prevent oil from traveling downward out of the bearing **80** and into the crusher chamber **50**.

A socket seal **100** prevents leakage of lubricants such as oil into crusher chamber **50**. The seal **100** maintains contact with shaft **20** while crusher **10** is operating. In the area of the seal **100**, the shaft **20** may move plus or minus 0.25 inches in a horizontal direction during gyration. The range of this movement is indicated by lines **108** and **110** in FIG. **2**. Additionally, the shaft **20** will rotate during crusher operation, so seal **100** must maintain contact with shaft **20** during rotational motion as well. In some crusher embodiments, the shaft **20** will move vertically with respect to the seal **100** as well.

Seal **100** is preferably stationary with respect to piston **82** and does not rotate in this embodiment. Rotation is prevented by slightly compressing seal **100** between socket **90** and piston **82**. The seal **100** must perform under a wide range of lubrication flows. This is because greater power crushers **10** require a higher bearing **80** lubricating oil flow than crushers **10** with lower power requirements. Lubrication oil flow rates can range from two to twenty gallons per minute.

Referring to FIG. **3**, socket seal **100** has two lips **102** extending from middle span **106**. Accordingly, seal **100** has a Y shape. Seal **100** also includes dovetail **104** that expands outwardly from middle span **106**. According to an alternative embodiment, seal **100** can include three or more lips similar to lips **102**. According to a still further embodiment, seal **100** could have a single lip **102**.

In a preferred embodiment, socket seal **100** has an inner diameter of 15.8 inches and an outer diameter of 19.8 inches. Lips **102** extend 1.6 inches from an outside bend **105** to an end **107**, and the angle between the two lips **102** is approximately 60 degrees. The middle span **106** has an inner diameter of 17.9 inches and an outer diameter of 19.0 inches. The middle span **106** is about 0.5 inches in height. The dovetail **104** has an inner diameter of 19.0 inches and an outer diameter of 19.8 inches. The dovetail is 1.2 inches in height at the outer diameter.

In alternative embodiments, the socket seal **100** dimensions may be changed to accommodate shaft and piston arrangements of differing sizes.

In a preferred embodiment, shaft **20** has an outer diameter of about 16.4 inches in the region where contact is made between lips **102** and shaft **20**. Because seal **100** has an inner diameter of 15.8 inches, and the range of gyratory axial motion is only plus or minus 0.25 inches, the lips **102** each maintain contact with the shaft **20** while the crusher **10** is operating.

In a preferred embodiment socket seal **100** is made of polyurethane, which may be impregnated with molybdenum disulfide. Alternative materials for seal **100** are rubber, Nitrite rubber, nylon, Viton, Teflon, or any flexible compound. The dovetail **104** is inserted into a slot or an aperture **112** in piston **82**, with the lips **102** extending inwardly making contact with shaft **20**. The flexible polyurethane material allows the lips **102** to maintain contact with shaft **20** over its full range of motion. The aperture is sized to retain dovetail **104**.

In an alternative embodiment a slot can be provided in shaft **20**. With such an embodiment, dovetail **104** is disposed in the slot on shaft **20** and lips **102** contact piston **82** or other fixed portion of crusher **10**. In a still further embodiment, seal **100** could be clamped on to shaft **20**.

The new socket seal arrangement has several advantages over conventional seals. First, the lips **102** provide redundancy for the sealing function. This is particularly important where a conventional wiper seal will not function adequately. The redundant lips **102** are able to seal in oil while excluding dust and contaminants from the bearing **80**. Second, the socket seal is reversible because it is symmetrical. Therefore, if there is uneven wear, the seal **100** can be reversed to give extra longevity, reducing operational costs. Third, the seal **100** requires no hardware for installation. Rather, it may be installed by hand by inserting the dovetail **104** into slot or aperture **112** in piston **82**. Conventional seals can require bolts or clamping to install the seal. Fourth, because of the lip design that includes a greater amount of overlap with shaft **20**, the seal **100** is able to withstand gyratory motion while maintaining contact with shaft **20** where conventional seals would lose contact with the shaft due to the large off-center movement of gyratory crushing operation. The length of lips **102** not only helps maintain contact between seal **100** and shaft **20**, but the long lips **102** reduce the stress on the seal material, spreading the lip deflection over a long span.

The socket seal **100** is installed as follows. The bearing **80** is removed through the top of the spider **46** by first decoupling the bearing retainer plate **92** from the shaft **20**. This will result in the shaft **20** not being clamped to the ball **94**. After removing the socket retaining ring **114**, the ball **94** and socket **90** can then be lifted out separately through the top of the spider assembly **46**. Because the aperture **112** is partially defined by socket **90**, the removal of socket **90** allows the removal of socket seal **100** from the retaining slot **112** in a direction parallel to the center axis of the shaft **20**.

A new seal **100** is installed by hand by placing the dovetail **104** into the vacant aperture **112** and then reinstalling the

socket **90** and ball **94** into the recessed in the spider **46**. The shaft **20** may then be reclamped to bearing **80** through the use of retaining plate **92**.

The gyratory crusher **10** operates as follows. When the drive mechanism **22** is driven by any appropriate means, mechanism **22** transmits power to the eccentric **24**. Eccentric **24** causes the gyration of the head assembly **26**, resulting in the crushing of the material in the crushing chamber **50**. The phantom lines flanking the mantle **34** and shaft **20** axis on FIG. **1** indicate the range of gyratory motion.

The above arrangement solves the longstanding problems discussed in the Background of the Invention section because the socket seal **100** does not lose contact with the shaft **20** during gyratory motion. Additionally, the socket seal **100** has a measure of redundancy with the two lips **102**. Further still, the socket seal **100** requires no hardware to be installed on the crusher **10**. Further, the socket seal **100** has a longer life span because it may be reversed.

While several embodiments of the invention have been described, it should be apparent to those skilled in the art that what has been described is considered at present to be the preferred embodiments of a spider piston socket seal. However, in accordance with the patent statutes, changes may be made in the design without actually departing from the true spirit and scope of this invention. The following claims are intended to cover all such changes and modifications which fall within the true spirit and scope of this invention.

What is claimed is:

1. A gyratory crusher, comprising:

a shell;

a spider supported by the shell;

a piston disposed within the spider;

a bearing assembly supported by the piston;

a shaft coupled to the bearing; and

an annular seal extending between the piston and the shaft, the seal having a plurality of lips.

2. The gyratory crusher of claim **1**, wherein the seal is made of polyurethane.

3. The gyratory crusher of claim **2**, wherein the seal is impregnated with molybdenum disulfide.

4. The gyratory crusher of claim **1**, wherein the seal is symmetrical about a horizontal plane.

5. The gyratory crusher of claim **1**, further comprising:

an outwardly expanding portion, extending from the seal in a direction opposite to the lips, wherein the outwardly expanding portion is retained in a slot in the piston.

6. The gyratory crusher of claim **5**, wherein the outwardly expanding portion is retained between the slot and a portion of the bearing assembly.

7. The gyratory crusher of claim **6**, wherein the lips are separated by an angle of 60 degrees.

8. The gyratory crusher of claim **5** wherein the slot is arranged to enable the seal to be installed therein or removed therefrom in a direction substantially parallel to a center axis of the shaft.

9. The gyratory crusher of claim **1**, further comprising:

an outwardly expanding portion, extending from the seal in a direction opposite to the lips, wherein the outwardly expanding portion is retained in a slot in the shaft.

10. The gyratory crusher of claim **1**, wherein the seal has at least two lips.

11. The gyratory crusher of claim **1**, wherein the seal has an inner diameter of about 16 inches and an outer diameter of about 20 inches.

12. The gyratory crusher of claim **1**, wherein the bearing assembly includes a hemispherical bearing.

13. A socket seal in combination with a gyratory crusher having a shaft supported by a bearing disposed within a piston, the seal comprising:

a ring with a first edge and a second edge; and

a plurality of lips extending from the first edge of the ring,

the seal disposed between the shaft and the piston, whereby the seal contacts both the shaft and the piston during operation of the gyratory crusher.

14. The combination of claim **13**, wherein the seal is made of polyurethane.

15. The combination of claim **14**, wherein the seal is impregnated with molybdenum disulfide.

16. The combination of claim **13**, wherein the seal is symmetrical about a horizontal axis.

17. The combination of claim **13**, further comprising:

an outwardly expanding portion, extending from the second edge, wherein the outwardly expanding portion is retained in a slot in the piston.

18. The combination of claim **17** wherein the slot is arranged to enable the seal to be installed therein or removed therefrom in a direction substantially parallel to a center axis of the shaft.

19. The combination of claim **13**, further comprising:

an outwardly expanding portion, extending from the second edge, wherein the outwardly expanding portion is retained in a slot in the shaft.

20. The combination of claim **13**, wherein the seal has two lips.

21. The combination of claim **13**, wherein the seal has three lips.

22. The combination of claim **13**, wherein the seal has an inner diameter of about 16 inches and an outer diameter of about 20 inches.

23. The combination of claim **20**, wherein the lips are separated by an angle of 60 degrees.

24. The combination of claim **13**, wherein the bearing is a hemispherical bearing.

25. A gyratory crusher, comprising:

a shell;

a spider supported by the shell;

a piston disposed within the spider;

a bearing supported by the piston, the bearing having a ball and a socket defining a lubricated interface;

a shaft supported by the bearing; and

a seal means for preventing lubricant from exiting the lubricated interface, the seal means having a plurality of lips disposed below the lubricated interface.

26. The gyratory crusher of claim **25**, wherein the seal means is made of polyurethane.

27. The gyratory crusher of claim **26**, wherein the seal means is impregnated with molybdenum disulfide.

28. The gyratory crusher of claim **25**, wherein the seal means may be installed by hand.

29. The gyratory crusher of claim **25**, wherein the seal means is symmetrical about a horizontal axis.

30. The gyratory crusher of claim **25**, further comprising:

an outwardly expanding portion, extending from the seal in a direction opposite to the lips, wherein the outwardly expanding portion is retained in a slot in the piston.

* * * * *